Huang 2000-0221

IN THE CLAIMS:

1. (Previously Presented) A method executed in a computer of computing a distance measure between first and second mixture type probability distribution functions, $G(x) = \sum_{i=1}^{N} \mu_i g_i(x)$, pertaining to a set data collected from a first source, and

$H(x) = \sum_{k=1}^{K} \gamma_k h_k(x)$, pertaining to another set of collected data, the improvement characterized by:

said distance measure being

$$D_M(G,H) = \min_{w=\{\omega_{ik}\}} \sum_{i=1}^{N} \sum_{k=1}^{K} \omega_{ik} d(g_i, h_k),$$

where $d(g_i, h_k)$ is a function of the distance between a component, g_i, of the first probability distribution function and a component, h_k, of the second probability distribution function where $\sum_{i=1}^{N} \mu_i = 1$, $\sum_{k=1}^{K} \gamma_k = 1$, $\omega_{ik} \geq 0$ for $1 \leq i \leq N$, and for

$1 \leq k \leq K$, where for at least one value of i $\omega_{ik} > 0$ for at least two values of k, and

$$\sum_{k=1}^{K} \omega_{ik} = \mu_i, 1 \leq i \leq N, \sum_{i=1}^{N} \omega_{ik} = \gamma_k, 1 \leq k \leq K, \text{ and}$$

making a determination, based on said computed overall distance as to whether said another set of collected data pertains to said source.

2. (Original) The method according to claim 1 wherein at least one of said first and second mixture probability distribution functions includes a Gaussian Mixture Model.

3. (Previously Presented) The method according to claim 1 wherein the element distance between the first and second probability distance functions is a Kullback Leibler Distance.

4. (Original) The method of claim 1 wherein the first and second probability distribution functions are Gaussian mixture models derived from audio segments.

2

Huang 2000-0221

5. (Previously Presented) A computer program embedded in a storage medium for computing a distance measure between first and second mixture type probability distribution functions, $G(x) = \sum_{i=1}^{N} \mu_i g_i(x)$, pertaining to a set data collected from a first source, and $H(x) = \sum_{k=1}^{K} \gamma_k h_k(x)$, pertaining to another set of collected data, the improvement comprising a software module of said computer program that evaluates said distance measure in accordance with equation:

$$D_M(G,H) = \min_{w=\{\omega_k\}} \sum_{i=1}^{N} \sum_{k=1}^{K} \omega_{ik} d(g_i, h_k),$$

where $d(g_i, h_k)$ is a function of distance between a component, g_i, of the first probability distribution function and a component, h_k, of the second probability distribution function where

$$\sum_{i=1}^{N} \mu_i = 1 \ and \ \sum_{k=1}^{K} \gamma_k = 1,$$

$$\omega_{ik} \geq 0, \ 1 \leq i \leq N, 1 \leq k \leq K,$$

there exists some value of i for which $\omega_{ik} > 0$ for at least two values of k, and

$$\sum_{k=1}^{K} \omega_{ik} = \mu_i, 1 \leq i \leq N, \sum_{i=1}^{N} \omega_{ik} = \gamma_k, 1 \leq k \leq K, \underline{and}$$

making a determination, based on said computed overall distance as to whether said another set of collected data pertains to said source.

6. (Original) The computer program according to claim 5 wherein at least one of said first and second mixture probability distribution functions includes a Gaussian Mixture Model.

7. (Original) The computer program according to claim 5 wherein the element distance between the first and second probability distance functions includes Kullback Leibler Distance.

3

Huang 2000-0221

8. (Original) The computer program of claim 5 wherein the first and second probability distribution functions are Gaussian mixture models derived from audio segments.

9. (Previously Presented) A computer system for computing a distance measure between first and second mixture type probability distribution functions,

$$G(x) = \sum_{i=1}^{N} \mu_i g_i(x), \text{ and } H(x) = \sum_{k=1}^{K} \gamma_k h_k(x), \text{ pertaining to audio data comprising:}$$

memory for storing said audio data;

a processing module for deriving one of said mixture type probability distribution functions from said audio data; and

a processing module for evaluating said distance measure in accordance with

$$D_M(G, H) = \min_{w=[\omega_{ik}]} \sum_{i=1}^{N} \sum_{k=1}^{K} \omega_{ik} d(g_i, h_k),$$

where $d(g_i, h_k)$ is a function of the distance between a component, g_i, of the first probability distribution function and a component, h_k, of the second probability distribution function,

where

$$\sum_{i=1}^{N} \mu_i = 1 \text{ and } \sum_{k=1}^{K} \gamma_k = 1,$$

and

$$\omega_{ik} \geq 0, \ 1 \leq i \leq N, 1 \leq k \leq K,$$

and there exists some value of i for which $\omega_{ik} > 0$ for at least two values of k,

and

$$\sum_{k=1}^{K} \omega_{ik} = \mu_i, 1 \leq i \leq N, \sum_{i=1}^{N} \omega_{ik} = \gamma_k, 1 \leq k \leq K.$$

10. (Original) The computer system according to claim 9 wherein at least one of said first and second mixture probability distribution functions includes a Gaussian Mixture Model.

4

Huang 2000-0221

11. (Original) The computer system according to claim 9 wherein the element distance between the first and second probability distance functions includes Kullback Leibler Distance.

12. (Original) The computer system of claim 9 wherein the first and second probability distribution functions are Gaussian mixture models derived from audio segments.

13. (Currently Amended) A method executed in a computer for computing a distance measure between a mixture type probability distribution function $G(x) = \sum_{i=1}^{N} \mu_i g_i(x)$, pertaining to a set data collected from a first source, where μ_i is a weight imposed on component, $g_i(x)$, and a mixture type probability distribution function $H(x) = \sum_{k=1}^{K} \gamma_k h_k(x)$, pertaining to another set of collected data, where γ_k is a weight imposed on component h_k comprising the steps of:

computing an element distance, $d(g_i, h_k)$, between each g_I and each h_k where $1 \le i \le N, 1 \le k \le K$,

computing an overall distance, denoted by $D_M(G,H)$, between the mixture probability distribution function G, and the mixture probability distribution function H, based on a weighted sum of the all element distances,

$$\sum_{i=1}^{N} \sum_{k=1}^{K} \omega_{ik} d(g_i, h_k),$$

wherein weights $\omega_{i,k}$ imposed on the element distances $d(g_i, h_k)$, are chosen so that the overall distance $D_M(G,H)$ is minimized, subject to

$\omega_{ik} > 0$ for at least two values of k for each value of i,

$$\sum_{i=1}^{N} \omega_{ik} = \gamma_k, \ 1 \le k \le K, \text{ and}$$

5

Huang 2000-0221

$$\sum_{k=1}^{K} \omega_{ik} = \mu_i, \quad 1 \le i \le N, \text{ and}$$

making a determination, based on said computed overall distance as to whether said another set of collected data pertains to said source.

14. (Original) The method according to claim 13 wherein at least one of said first and second mixture probability distribution functions includes a Gaussian Mixture Model.

15. (Original) The method according to claim 13 wherein the element distance between the first and second probability distance functions includes Kullback Leibler Distance.

16. (Original) The method of claim 13 wherein the first and second probability distribution functions are Gaussian mixture models derived from audio segments.

17. (Currently Amended) A method executed in a computer for content-based searching of stored data comprising the steps of:

identifying segments in said data;

developing a probability distribution function for each of said segments from data points within each of said segments;

developing a distance measure between a probability distribution function of a chosen data segment and probability distribution function for said segments; and

applying a threshold to the developed distance measure to identifying segments with a distance measure relative to said chosen data segment that is below a preselected threshold value, where said distance is directly computed according to a measure that guarantees to satisfy the non-negativeness, symmetry, and triangular inequality properties of a distance measure; and

outputting a determination regarding said chosen data segment is closely related to said segments of said stored data..

6

Huang 2000-0221

18. (Previously Presented) Them method of claim 17 where said chosen data segment is one of said segments, or a provided data segment.

19. (Previously Presented) The method of claim 17 where said stored data is audio-visual data.

20. (Previously Presented) The method of claim 17 where said stored data comprises segments that carry speech of a speaker.

21. (Previously Presented) The method of claim 20 where a segment of said segments is characterized by a speaker that predominates an audio signal associated with said segment.

22. (Previously Presented) The method of claim 20 where said chosen segment is a segment that carries speech of a particular speaker.

23. (Previously Presented) The method of claim 17 where said data is of a television program.

24. (Previously Presented) The method of claim 17 where said distance measure between a first probability function, $G(x) = \sum_{i=1}^{N} \mu_i g_i(x)$, and a second probability

function, $H(x) = \sum_{k=1}^{K} \gamma_k h_k(x)$, is

$$D_M(G,H) = \min_{w=[\omega_{ik}]} \sum_{i=1}^{N} \sum_{k=1}^{K} \omega_{ik} d(g_i, h_k),$$

where

- $d(g_i, h_k)$ is a function of the distance between a component, g_i, of the first probability distribution function and a component, h_k, of the second probability distribution function,

7

Huang 2000-0221

- $\sum_{i=1}^{N} \mu_i = 1$ and $\sum_{k=1}^{K} \gamma_k = 1$,

- $\omega_{ik} \geq 0,\ 1 \leq i \leq N, 1 \leq k \leq K$,

- $\sum_{k=1}^{K} \omega_{ik} = \mu_i,\ 1 \leq i \leq N,\ \sum_{i=1}^{N} \omega_{ik} = \gamma_k,\ 1 \leq k \leq K$, and

- there exists some value of i for which $\omega_{ik} > 0$ for at least two values of k.

    25. (Previously Presented) A method executed in a computer comprising the steps of:

    identifying speaker segments in provided audio-visual data based on speech contained in said data;

    developing a probability distribution function for each of said segments from data points within each of said segments; and

    developing distance measures among said probability distribution functions, where each of said measures is obtained through a one-pass evaluation of a function that guarantees to satisfy the non-negativeness, symmetry, and triangular inequality properties of a distance measure.

    26. (Previously Presented) The method of claim **25** where said distance measure between a first probability function, $G(x) = \sum_{i=1}^{N} \mu_i g_i(x)$, and a second probability function, $H(x) = \sum_{k=1}^{K} \gamma_k h_k(x)$, is

$$D_M(G,H) = \min_{w=\{\omega_{ik}\}} \sum_{i=1}^{N} \sum_{k=1}^{K} \omega_{ik} d(g_i, h_k),$$

where

- $d(g_i, h_k)$ is a function of the distance between a component, g_i, of the first probability distribution function and a component, h_k, of the second probability distribution function,

- $\sum_{i=1}^{N} \mu_i = 1$ and $\sum_{k=1}^{K} \gamma_k = 1$,

8

Huang 2000-0221

- $\omega_{ik} \geq 0,\ 1 \leq i \leq N,\ 1 \leq k \leq K$,

- $\sum_{k=1}^{K} \omega_{ik} = \mu_i,\ 1 \leq i \leq N,\ \sum_{i=1}^{N} \omega_{ik} = \gamma_k,\ 1 \leq k \leq K$, and

- there exists some value of i for which $\omega_{ik} > 0$ for at least two values of k.